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ABSTRACT

The problems and extent of adult illiteracy are presented in this workshop report, which explores how computer and communication technology might be applied in adult literacy education. The introduction provides statistics and a discussion of past and current attempts to teach illiterate adults. The major portion of the report focuses on what literacy is and how technology might be used to facilitate the teaching of reading, writing, and related skills. The report concludes by offering recommendations pertaining to five topics: principles and perspective, research, development, service delivery, and evaluation. (HOD)

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Technical Report No. 351

ADULT LITERACY AND TECHNOLOGY

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This report follows from a two-day workshop on Adult Literacy and Technology, convened by the Adult Literacy Initiative of the U.S. Department of Education on October 1 and 2, 1984 and funded by the National Institute of Education under Contract NIE-C-400-81-0004. The workshop organizers were Monte Penney and Mary Cross of the Adult Literacy Initiative. The workshop's mandate was to explore how technology--and in particular computer and communication technology--might be applied to the task of teaching literacy to adults. Production of this paper was supported in part by the National Institute of Education under Contract No. 400-81-0030. It does not, however, necessarily reflect the views of this agency.

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Abstract

Illiteracy among adults is a serious national problem in the United States and elsewhere. Attempts to alleviate the problem have worked only marginally well. Recently the Adult Literacy Initiative of the United States Department of Education convened a workshop to address the question of how technology might be used to teach reading, writing, and related skills to adults. This is the chairman's report of that workshop. It begins with an overview of the problem of illiteracy among adults. There follow discussions of what it means to be literate, of considerations pertaining to the teaching of literacy, of how technology relates to literacy, and of some possible ways in which technology might be used to facilitate the teaching of reading, writing, and related skills. Several specific recommendations are made regarding the exploitation of these possibilities.

Adult Literacy and Technology

Adult illiteracy is a serious national problem. Its precise magnitude is difficult to estimate, but there can be no doubt that it is large. It represents an enormous cost not only to the individuals who cannot read or write but to society as a whole. The problem is disproportionately represented among the population and is most prevalent among disadvantaged or socially alienated groups. Attempts to remediate the problem--of which there have been many--have been only marginally successful.

In recent years, research has yielded new insights regarding reading and writing as cognitive processes. Also during the recent past, technology--and in particular information technology--has been advancing very rapidly. Together, the new research-based perspectives on literacy and the potential that information technology has for instructional uses offer hope for the development of more effective approaches to the problem.

The Problem

Some Statistics

The incidence of illiteracy among adults in the United States has proven to be difficult to quantify, but estimates have gone as high as almost half the adult population (Hunter & Harman, 1979). Perhaps the most widely cited statistics derive from the Adult Performance Level (APL) study, which was conducted by the University of Texas at Austin in 1975. According to this study, 23 million American adults are sufficiently illiterate to

have great difficulty functioning in our society, while an additional 40 million function, but not proficiently (Adult Performance Level Project, 1977). Assuming that the percentages have remained constant as the population has grown, the 23 million would have gone to 27 million, the 40 million to 47 million, and the total to 74 million by 1983 (Department of Education, 1983).

Both the methods and conclusions of the APL study have been challenged (Cervero, 1980; Griffith & Cervero, 1977) but the criticisms have not received as wide attention as the study report, and one finds the figure of 23 million being quoted widely without questions both in professional journals and in the press. It is not necessary, however, to accept the numbers from the APL study without reservation to believe that the problem of illiteracy in the United States is a serious one.

> The National Academy of Education's Committee on Reading (Carroll & Chall, 1975) used one in twenty as the percentage of U.S. adults who have not attained "minimum" literacy and one in two or three as having less than a twelfth-grade literacy level.
>
> According to a study conducted by the National Assessment of Education Progress, only about half of the country's 17-year-olds can write a wholly satisfactory piece of explanatory prose and only about 15 percent can defend a

point of view effectively with a persuasive argument (NAEP, 1981).

A recent study of the Chicago public school system revealed that nearly half of the 39,500 students who were freshmen in 1980 failed to graduate and that only about one-third of those who did graduate could read at or above the national twelfth grade level (Tugend, 1985).

Over one quarter of the Army's enlistees are sent to remedial reading class to acquire sufficient reading competence to be able to read training manuals written for the seventh-grade reading level (Norton, 1982).

According to a fact sheet from the 1979 White House Conference on Library and Information Sciences, the literacy rate of the United States is lower than that of Western European nations and the Soviet Union.

While such figures are shocking, they fail to portray adequately either the complexity of the problem or the enormity of the challenge it represents for the nation. A particularly troublesome aspect of the problem is the fact that people lacking literacy skills are disproportionately represented among disadvantaged minorities, the unemployed, the poor, and the disaffected.

According to the APL study, an estimated 13 percent of all 17-year-olds in the U.S. are functionally illiterate,

whereas for minority youth the figure may be as high as 40 percent (Adult Performance Level Project, 1977).

According to U.S. Department of Labor estimates, people who lacked basic reading and writing skills accounted for about 75 percent of the unemployed in 1982 (Toch, 1984).

Over one-third of the mothers receiving Aid to Families with Dependent Children are not literate (U.S. Department of Education, 1982).

Eighty-five percent of the juveniles who appear in court are not literate (Adult and Continuing Education Today, 1983).

An estimated 60 to 80 percent of prison inmates are functionally illiterate (Boorstin, 1984: U.S. News & World Report, 1982).

Whose Problem is Illiteracy?

Illiteracy is everybody's problem. It is the problem of the person who lacks literacy, because it limits one's ability to compete in the work-place, it narrows one's options for communication and information acquisition, and it impoverishes one's intellectual life in numerous ways. It is the problem of local, state, and national governments, because it represents a cost to taxpayers and necessitates the maintenance of various programs to provide for people whose job opportunites are severely limited. It is the problem of institutionalized education, because a high incidence of adult illiteracy is stark evidence of failure of the educational system as a whole. It is

the problem of society in general, because it promotes the kinds of inequities that fuel social conflict, disorder, and discontent.

Illiteracy is a fundamental and profound problem to the nation, because only to the degree that its citizens are sufficiently well informed to participate meaningfully in the political process, which means being able to understand political issues and to evaluate arguments that are made with respect to them, can a democratic society expect to survive and prosper.

The ability to assimilate new information and acquire new knowledge and skills is a critical one in any society, but especially in one that is undergoing rapid change as consequence of technological innovation. The person who cannot read or write is deprived of a major avenue of learning and is a risk in such a society that tolerates a high incidence of illiteracy among its populace is itself at risk in today's complex world.

Literacy and Employment

The point was made that illiteracy limits one's ability to compete in the workplace, and so it does. We want to be sure that this assertion is not misinterpreted. It is a small step from the identification of illiteracy as a cause of unemployability to the conclusion that a high rate of illiteracy represents a negative impact on the Gross National Product by effectively keeping some people out of the labor force. It is important to keep two issues separate here. We do not assume

that universal literacy would necessarily lead to full employment. If job opportunities are limited by demand for literate labor rather than by supply, increasing the supply will have little effect on the unemployment rate. For the individual, however, literacy can indeed make the difference between being able to compete effectively for available jobs and being completely out of running.

Levine (1982) has challenged the legitimacy of increased employment opportunities as the major motivation for attempting to acquire skills of literacy. He points out that the low levels of literacy that have often sufficed to qualify as functional are not likely to enhance greatly one's employability. What may be a more effective motivator, he suggests, is personal pride:

> a lack of competence in reading and writing, exemplified by the inability to comprehend printed materials in common use, by misspellings and grammatical errors, earns negative social esteem or a stigma. In most industrial societies, this stigma is pervasive and damaging, and many adults desperately seek to master literacy not merely in the hope of employment, or solely for its obvious practical utility, but partly in order to gain or preserve esteem among family and peers (p. 259).

While we acknowledge the significance of personal pride as a major factor in motivating the acquisition of literacy - as well as many other types of skills - we believe strongly that the practical desire to increase one's job opportunities is also a

common and legitimate reason for wanting to learn how to read and write. But that there is a risk of encouraging false hopes by promoting the idea that small increases in literacy will invariably lead to major enhancement of vocational or economics status is a point well taken. For most people who are functionally illiterate, the kinds of improvements necessary to increase job opportunities significantly will probably involve a rather considerable effort over an extended period of time. Unrealistic expectations resulting from failure to acknowledge this fact may go some way toward accounting for the very high drop-out rate that often plagues literacy training programs (Carroll & Chall, 1975).

Failure to assess realistically not only the time and effort required to increase literacy significantly but also the level of literacy essential to acceptable performance in many jobs may be at the root of difficulties with federally funded job training programs. Such programs (MDTA, CETA, and now JTPA) have been plagued by high attrition rates during training and unimpressive rates of continued employment by those trainees placed on jobs after completion. In addition to a job training component, most of these programs have a much smaller basic education component, in recognition of the lack of basic skills among the target group out of which trainees are usually recruited. Most of the occupations for which training programs have been developed require at least a seventh-grade reading level and a working

knowledge of fractions, decimals, and often some algebra and geometry.

This combination of factors creates a catch-22 situation. Requirements for success in the program and on the job exceed the abilities of many of the trainees. The basic-skills component of programs typically is not of sufficient duration to prepare these students adequately for the job-training component. Even if adequate basic-skills components were included, it would be difficult to maintain student interest and motivation for the hundred hours or so of classroom time typically needed to raise a student one grade level in reading using traditional methods. If federally financed job-training programs are to be successful, more time-effective methods for teaching the basic skills of literacy must be used.

Need for New Approaches

The problem of illiteracy has proven to be a particularly recalcitrant one. Lack of significant progress on it is not the result of lack of attention. The "reading problem" has been a major concern of the Federal Government at least since James E. Allen Jr. focused attention on it by initiating the Right to Read program while he was U.S. Commissioner of Education in the early 1970's (Allen, 1970). The problem has been widely discussed by the media for years. Numerous literacy training programs have been established at national, state, and local levels. Weber (1975, p. 147) points out that:

> in the 1960's, at least ten major federal agencies were authorized by nearly 30 laws to teach reading to adults (Greenleigh Associates, 1968), while more than 600 nongovernmental agencies were engaged in adult basic education (Cortright & Brice, 1970).

A national guide to literacy facilities and services published by the Contact Literacy Center (Kadavy, Moore, & Hunzeker, 1983) lists 39 national literacy programs and several thousand state-level resources.

In spite of these facts, formal adult literacy programs are reaching only about 2 to 4 percent of the population in most serious need of them, according to Hunter and Harman (1979). The search for effective approaches to the problem continues. In September 1983 President Reagan announced an Adult Literacy Initiative, which was to contain the following eight elements: a national awareness campaign, a national adult literacy project, establishment of state and local adult literacy councils, funding of college work-study adult literacy programs, provision of college credit for literacy tutoring, networking of Department of Education units involved in literacy training, establishment of a program to involve federal employees as literacy tutors, and establishment of a Department of Education liaison with volunteer and private sector groups (Office of the Press Secretary, The White House, 1983b).

Very recently, the Librarian of Congress, Daniel Boorstin (1985), called on the Federal Government and the private sector to set as a national goal the abolition of illiteracy in the country by 1989, the bicentennial year of the Constitution.

> There would be no better manifest of our determination to fulfill the hopes of our founders and justify the faith that a free people can provide themselves and their children with the knowledge that will keep them free (p. 27).

Boorstin's challenge was made in a report from a study commissioned by Congress on the role of the book in the society of the future.

In view of how difficult it has been to make significant headway on the problem of illiteracy in the past, the goal of abolishing illiteracy during the next few years is an enormously ambitious one--even assuming that it is clear what the abolition of illiteracy means. While we wholeheartedly endorse this goal, we believe that there is essentially no possibility of realizing it, or of coming close to doing so, unless (1) very substantial national resources are committed to its attainment, and (2) methods of teaching literacy are developed that are more effective than those that have been used in the past.

Some New Perspectives

Fortunately, there is reason to believe that the prospects of developing more effective techniques for teaching literacy are

greater now than heretofore. Much has been learned about reading and writing processes as a consequence of research in recent years. While this research has led to a greater awareness of the complexity of these processes--and especially their cognitive aspects--it has also provided the basis for a better understanding of various impediments to literacy and what might be done to address them.

Writing has probably always been viewed as an active, creative process. In contrast, reading was once viewed as the relatively passive process of extracting meaning from print. It was assumed that one did this primarily by recognizing the printed representations of words. The meanings of sentences were determined by the meanings of the words that comprised them, so if one recognized the words and knew their meanings, comprehension followed. The situation is now known to be far more complicated than this. To be sure, the meanings of sentences are determined by the meanings of words that comprise them; but it is equally true that the meanings of the words are highly dependent on the contexts in which they occur. And sentences, in turn, derive their meanings, to a large degree, from the extrasentential contexts in which they are embedded.

Reading now is viewed as a process of imposing meaning on print as much as one of extracting meaning from it (Adams, 1980; Anderson, Spiro, & Anderson, 1978; Bransford & Johnson, 1973; Collins, Brown, & Larkin, 1980; Rumelhart, 1980; Spiro & Stein,

1980). This is not to deny the importance of decoding skills but simply to recognize that reading is a process that depends heavily on knowledge of various types that the reader brings to the task: knowledge of linguistic conventions, of the specific topic, of the world in general, of the writer's (assumed) purpose and intended audience, of the genre of the written material, and so forth. Comprehension is not an either-or affair, but a matter of degree.

The current view of reading also recognizes the latitude readers have to approach a reading task in a variety of ways, to read for different purposes, and to monitor and manage consciously their reading behavior. Various techniques have been studied for facilitating comprehension, and retention. Numerous studies have addressed the question of how competent readers differ in their approach from less competent readers. Much of this work has focused on strategies and metacognitive variables, and has been motivated by an interest in obtaining information that could be used to help improve the comprehension skills of less able readers.

A Challenge for Technology

It is in this context of a widely recognized national problem of major proportions that has not yielded to conventional solutions, and of a growing body of research findings relating to literacy and its development, that the question of the potential applicability of technology is raised. Does technology have

anything of value to offer toward the rectification of the current situation? Might it help to address the problem of too few tutors by making the services of effective tutors available to more people or by opening new possibilities for self-tutoring? Can technology be the basis for the development of tools that will enhance the effectiveness of tutors? Does it have the potential to support the development of qualitatively different cost-effective training techniques? Might it help address the problems of motivation and commitment? Can it be used to provide greater flexibility with respect to time and place of training?

These are the kinds of questions that come to mind as we begin to think about the possible roles of technology in literacy training. The purpose of the workshop from which this report comes was to consider such questions with the intention of identifying some possibilities for applying technology to literacy training and of recommending some specific courses of action.

While this report focuses on the United States, we recognize that illiteracy is an international problem and an especially severe one for the third world, where in many countries the incidence is greater than 50 percent. We note in passing that increasing literacy worldwide has been a continuing goal of UNESCO (Blaug, 1966) and indeed, is viewed by the organization as a fundamental human right (Blataille, 1976). Although it would be unwise to assume that approaches developed for application in

the United States will be equally suitable for use elsewhere, it seems reasonable to expect some degree of transferability from one context to another.

Literacy

What is Literacy?

In the most general terms, literacy might be considered to be proficiency in the production and interpretation of symbols that are used for purposes of communication within one's culture. In its narrowest use, it connotes the ability to interpret print and to write--ability with letters, to be quite literal about it.

But even with the narrower connotation, one is left with a sense of uncertainty about what being literate really means. Does it mean being able to write one's name, to fill out an application form, to read well enough to pass a driver's test, to read and understand a newspaper, to write a business letter, to express oneself grammatically and effectively, to read technically complicated material comprehendingly, to use language with a high degree of skill and competency? Sometimes the term literate is used to mean "well read" and, in particular, well read with respect to "literary" works. There are many people who can read the newspaper, who would not be considered literate by this definition.

Perhaps the least debatable observation that we can make about literacy, as the term has been used in the past, is that its connotation has changed considerably over time. It also has

varied from place to place. In Scribner's (1984) words, "literacy has neither a static nor a universal essence." Until fairly recent times the primary evidence of literacy in the United States was the ability to write one's name (Clanchy, 1981, Resnick & Resnick, 1977). In the 1940 U.S. Census it was assumed that anyone who had completed the fourth grade could read (Graham, 1981); more recently the Bureau of Census criterion for literacy has been completion of six years of schooling. Bormuth (1975) has criticized the practice of defining literacy this way on the grounds that test results provide little evidence that the completion of a few years of schooling guarantees any given degree of literacy at all. In very recent years the idea of what it means to be literate has been expanded to acknowledge the role of higher-order cognitive skills in reading and writing, and increasing emphasis has been placed on the importance of determining what is needed by way of literacy skills to permit one of function in modern society.

If we define literacy as the ability to read comprehendingly, we must recognize that it is a gross oversimplification to think of the world as being populated by two classes of people: those who are literate and those who are not. The reality is much more complex than that. Literacy is a matter of degree. Moreover, a given individual may be highly literate with respect to some knowledge domains, and relatively illiterate with respect to others. The fact that one can read

comprehendingly about cooking or astronomy does not provide good evidence that they can do so also about biology or sports.

One can easily extend this line of reasoning to the conclusion that we are all illiterate with respect to many, if not most, areas of human knowledge. There is a thought here that is worth pursuing, but it would be a digression from the main focus of this report. For the most part, it will suit our purposes to think of literacy as the ability to read comprehendingly material that has been written for non-specialist readers or "general audiences," which is to say what one typically finds in newspapers and popular magazines, and to have sufficiently good writing skills to compose such things as a narrative description of one's work history, and opinion on a topic of personal interest, or instructions for and activity with which one is familiar.

The Concept of Functional Literacy

It was noted above that definitions of literacy have increasingly emphasized the importance of reading and writing in permitting one to function in society. The term "function literacy" is frequently encountered in the educational literature, and in the popular press, but what it is supposed to mean is not always clear.

Gray (1956, p. 24), in a widely distributed report of a survey sponsored by UNESCO, spoke of a functionally literate person as one who has "the knowledge and skills in reading and

writing which enable him to engage in all those activities in which literacy is normally assumed in his culture or group."

A definition in a recent White House press release goes as follows: "the possession of the essential knowledge and skills to enable an individual to function in his or her environment--at home, in the community, in the workplace" (Office of the Press Secretary, The White House, 1983a). This is similar to Hillerich's (1976, p. 53) definition of literacy as "demonstrated competence in communication skills which enables the individual to function, appropriate to his age, independently in his society and with a potential for movement in the society."

Unfortunately, definitions that refer to one's ability to function in one's environment are not very helpful apart from an explanation of what is meant by "function" in this context. It is apparent that, in some sense, many people who lack literacy do, in fact, function in modern society. They hold jobs, pay taxes, raise families, and "get by."

The following definition, offered by the Coalition for Literacy, gives one indication of what might be meant by functioning: "the ability to complete the basic tasks necessary to function in today's society, such as reading and comprehending written directions, labels, applications, street signs, safety instructions, and job information" (Coalition for Literacy, undated). Again, one is left with less than closure, however, because of vagueness regarding what it means to comprehend.

Clearly, comprehension is not a binary affair--we comprehend to different degrees, and what constitutes adequate comprehension for practical purposes varies with the context.

Guthrie and Kirsch (1984) have argued that the traditional view of literacy is an oversimplified one involving the assumption that literacy is a unitary capability--that there is only one kind of literacy--and the assumption that a person either has acquired it or has not. They defend the view that literacy, and in particular reading ability, is conditioned by the social context--including the reader's expectations and purposes--in which it occurs. Different social contexts imply different types of reading demands. It follows that an individual could be literate for some purposes, while not for others; and whether one was judged to be literate or illiterate could depend on the evaluation technique.

It is somewhat ironic that while the major indicator of literacy was for many years the ability to write one's name, most recent discussions of literacy have focused primarily on reading. In Clifford's (1985, p. 478) words: "Dominant conceptions of functional literacy stress reading competencies of a certain kind and relatively ignore writing." To be sure, one cannot be literate without being able to read. However, the ability to write is also part of being literate and there is some concern, legitimate we believe, that writing has been undervalued by many

literacy-enhancement efforts, judging from the attention it gets relative to what reading receives.

Levine (1982) has taken a somewhat cynical view of what he sees as a disproportionate emphasis on reading and lack of attention to writing in functional literacy programs. The ability to read well enough to interpret instructions, labels, and signs has limited capacity, he notes, to help the possessors of such skill to remedy such problems as unemployment, low pay, or inadequate housing. Such limited abilities, he suggests, are representative of the:

> types of communication generally intended to elicit passive behaviors or to encourage conformist responses that reproduce or further institutionalize existing social arrangements. It appears that a functional competence has been defined so that it is merely sufficient to bring its possessor within the reach of bureaucratic modes of communication and authority . . . Writing, in all but its most rudimentary forms, is omitted from existing conceptions and operationalizations of functional literacy. Yet it is, on the whole, writing competencies that are capable of initiating change. Writing conveys and records innovation, dissent, and criticism; above all, it can give access to political mechanisms and the political process generally, where many of the possibilities for personal and social transformation lie (pp. 261-262).

The authors of the 1975 report of the National Academy of Education's Committee on Reading (Carroll & Chall, 1975) dismiss the claim that the teaching of reading is a form of political subjugation and argue that:

> the simplest, and to us, the most pervasive argument for literacy is that an individual cannot fully participate in modern society unless he can read, and by this we mean reading at a rather high level of literacy. The options available to a nonliterate person, with "minimum literacy," are much more limited than those available to one who can read, and read well, at the twelth grade level of difficulty or higher (p. 9).

We note the emphasis here on the importance of being able to read well, at a rather high (e.g., twelfth grade) level, which the authors of the report define operationally as: "roughly, the ability to read with understanding nearly all the material printed in a magazine like Newsweek" (p. 8). They see attainment of this level of literacy by all adults as a meaningful national goal. Carroll (1974) justifies such an ambitious goal by noting the widespread use of print in our culture and the fact that some of the ideas people are expected to be able to handle are of sufficient complexity as to require language of twelfth-grade reading difficulty for expression.

If we accept this view, we seem to be obliged to acknowledge either (1) that functional literacy should be defined in considerably more ambitious terms than it typically has been in the past, or (2) that if we accept a lesser criterion for functionality, we must conclude that functional literacy is not an adequate goal. In either case we recognize that an appropriate level of aspiration for a serious attack on the problem of adult illiteracy goes considerably beyond giving people the ability to interpret instructions, labels, and signs--which is not to deny the importance of being able to do these things.

To some readers of this report, a twelfth grade reading level may seem to be an unreasonably ambitious goal to set for adult literacy programs. It must be viewed, however, in light of the fact that ours is an extremely print-oriented society, in spite of the heavy usage also of other communication media. Using census and index data from various sources covering the period from 1962 to 1977, Pool (1983) has estimated that the number of words read from print media per day by an adult in the United States averaged about 10,000 over that time. (Pool's figures show the number decreasing from about 11,000 in 1962 to about 8,500 in 1977.) Given that (according to estimates we have already considered) a significant fraction of the adult population reads little if anything at all, we must assume that the average for those adults who do read is probably somewhat

higher than Pool's figures indicate. But even 10,000 words is rather a lot--about 40 pages of typed text (double-spaced on 8 1/2" x 11" paper). If anything close to this is what the average literate adult in our society reads, day in and day out, it is easy to understand how the ability to read at no better than a fourth-or sixth-grade level could put one at a serious disadvantage with respect to functioning effectively in mainstream activities--vocational or social--of modern-day life.

Moreover, setting a relatively high goal for literacy training is the obvious answer to those critics of literacy programs who have seen them as increasing people's susceptibility to manipulation by the government, business and other users of the printed word. As Clifford (1985, p.#496) wryly observes:

> If literacy has been demeaning as often as empowering, as the left sometimes contends, and if the literate are only semi-literate because they have failed to learn the fuller ranges of the values of literacy, as the intelligentsia believes, the only solution seems to be more literacy, of the expansive kind that has brought such insights and values to the critics' consciousness.

The Teaching of Literacy

How best to teach reading has been a controversial question among educators. Quite different ideas on the subject have prevailed at different times. Singer (1981) traces the history of the philosophy of reading instruction in the United States

through several periods that emphasized first the alphabet method (in which reading was taught through a focus on the smallest unit of text, the letter), the whole word method, the phonics method, the sentence method and the language-experience method. He notes also that there has been some switching back and forth between methods.

Chall (1967) characterizes approaches that have been taken to the teaching as falling on a continuum, the ends of which are represented by an emphasis on coding and decoding at one end and on meaning at the other. Both methods progress from easier to more difficult materials. The evidence is not clear regarding which of them has been more effective (Singer, 1981). Moreover one cannot assume that because one teaching method gives faster results initially that it will be a better method as judged by longer-term results (Ruddell, 1968). Conclusions about the effectiveness of any method must be interpreted in light of the criterion measures by which effectiveness was assessed. Because a method is effective in increasing students' sight vocabulary, for example, it does not follow that it is equally effective in increasing reading comprehension.

One widely accepted conclusion about the teaching of reading that has come out of recent research is that much greater attention must be given to cognitive and metacognitive aspects of reading than has been true in the past. Increasing recognition of reading as a knowledge-based, constructive activity that

involves the generation and testing of hypotheses, the imputation of purpose and intent, the interpretation of contextual clues to meaning, and a variety of other "top-down" processes, dictates the need for approaches to the teaching of reading that take these factors into account.

Reading ability and knowledge are increasingly recognized as mutually reinforcing and interdependent entities. Certainly, one of the most effective ways of acquiring knowledge in our culture is through reading; a person who is unable to read has a serious disadvantage with respect to knowledge acquisition. On the other hand, reading itself is a knowledge-dependent activity, and one's ability to read can be seriously impaired by an inadequate knowledge base. The more one reads, the more one is likely to know, which in turn will make it increasingly easier to read and thereby to learn. Conversely, the adult who cannot read is sure to have a limited knowledge base, which will tend to inhibit development of the very skills that would facilitate the expansion of what he knows.

Writing instruction, like reading instruction, has changed over the years. The earliest writing instruction focused on the mechanical aspects of the process--skills that we would now describe as penmanship. Later, the teaching of writing included grammatical topics, and required students to memorize and apply language rules. Throughout the twentieth century, writing instruction has alternately embraced and rejected such features

as oral language exercises, creative expression, letter writing, patterning exercises, and literature as a model. On the other hand, sentence construction, paragraph development, and grammar have been constants in the major textbooks of the past several decades (Donsky, 1984).

In the recent past a new approach to writing instruction has crystallized and grown (Graves, 1983). While the underlying principles of this approach have roots in earlier textbooks (Baker & Thorndike, 1912; Burleson, Burleson, & Cash, 1952), there is a coherence to the new view that may herald long-lasting changes. The focus of the "process" approach to writing is on the complex development of a piece of text. Students are encouraged to choose their own topics, go through multiple drafts of a piece, confer about their piece with both teacher and peers, share their compositions publicly when they are ready, and question one another's writing decisions. Reading instruction and writing instruction are seen as intimately and inevitably connected, and teachers are urged to participate with their students as both readers and writers. While there have not been many formal experiments comparing this approach with more traditional methods, reports from researchers, teachers, and students have been strongly positive (Gordon, 1984).

What little is known about the relative merits of various approaches to the teaching of reading and writing has been learned from studies of the acquisition of reading and writing

skills by children, and its applicability to the problem of adult illiteracy is questionable. Adult illiteracy differs from childhood preliteracy in a variety of ways. The adult brings to the situation more extensive knowledge about many aspects of the world, different motivation for wanting to be able to read, different time constraints, and different status as a consequence of being unable to read or write.

One thing is apparent; the general approach that is followed in primary school of devoting the first year or two of reading instruction almost entirely to the teaching of basic decoding skills, and only after the phase gradually increasing emphasis on reading for the purpose of acquiring information from text (Singer, 1981), is unlikely to work well with adults. Methods must be used that get people quickly reading for information and writing for the purpose of communicating, because few adults are likely to continue in a program that devotes months to basics before developing skills that they can perceive as useful in their present daily lives.

Recognition of the interdependence of literacy and knowledge makes it clear that one cannot hope to develop either very extensively without paying some attention to the other. Perhaps of greatest relevance in the present context, however, is the fact that illiterate adults face the task of learning to read with a qualitatively different knowledge base than do preliterate children. Adults have some knowledge of the world by virtue of

having lived in it for several years. It is important to recognize also that adults are very likely to have misconceptions about many aspects of the world. The desire for explanations is a deeply ingrained human trait; lacking better sources of explanations, we make up our own. The ability of adults to comprehend what they are reading when they are beginning to learn to read is as likely to be limited by misconceptions that they bring to the task as by the lack of information. Programs to teach literacy to adults should be designed not only to take advantage of knowledge about the world that they have, but also to be sensitive to the misinformation and misconceptions that they have as well.

Reasons for Learning to Read and Write

What would people who lack literacy skills want to read, if they could read? Surely, the answer to this question is that different people would want to read different things, and that it is therefore risky to design programs around specific material on the assumption that that is what people lacking reading skills would naturally want to read, if they could. It is also risky to assume that most nonreaders would be interested in reading what literate designers of reading programs themselves like to read, or even what the designers would like nonreaders to read. More efforts to ascertain what specific individuals who lack reading skills would read spontaneously if they could would be helpful.

There is, of course, the possibility also that not all adults who cannot read have a strong desire to read anything.

Among the reasons why an adult who cannot read, or write, might want to be able to do so are the following: to pass a driver's test; to fill out an employment application; to read to children; to pass a GED test; to qualify for a job; to read and write letters; to follow a cooking recipe; to read the TV guide, a road map, food container labels, warning signs, directional signs, a menu, want ads, entertainment notices, a bus or train schedule, medicinal instructions, newspaper headlines, or training material. Anecdotal data suggest that one of the more common desires is a very old one, and one that was a major driving force behind the mass literacy movement that followed the Guttenberg breakthrough in technology some 500 years ago; namely, the desire to read the Bible. There is also the possibility, which--strangely--seems often to be overlooked, that some people who cannot read would like to be able to read widely for both information and pleasure.

Several investigators have attempted to identify various purposes for which people who can read do read. Some of the lists that have been proposed contain a dozen or more entries (Gray & Rogers, 1956; Miller, 1982). These include acquiring knowledge, editing reports, filling time, understanding current happenings, self-improvement, and satisfying personal, social or spiritual needs. Guthrie and Kirsch (1984) suggest that, to the

degree that purposes for literacy are diverse, competency must be diverse also.

Literacy and Motivation

It is tempting to make a distinction between people who cannot read or write, but are highly motivated to learn to do so, and those who have little or no interest in becoming literate. While motivation is an issue that must be addressed, this distinction is probably an oversimplification in several ways. First, motivation is not an either-or affair; people are motivated to do things to varying degrees. We suspect that most people who cannot read or write would, if asked, admit to wishing they could do both. The practical question is whether the desire is strong enough, given whatever opportunities and disincentives may exist. Possible disincentives include such obvious factors as financial cost (of tuition, transportation, baby-sitting fees) and time away from other activities. They include also more subtle, but no less real, factors such as the prospects of change of status within one's peer group, anticipated changes in life-style resulting from being literate, and added responsibilities that come with new skills. The problem of motivation is a multi-faceted one and needs to be addressed with sensitivity to the fact that literacy, or illiteracy, exists withing specific sociocultural contexts.

Closely associated with the question of how to motivate people to learn to acquire literacy skills is that of how to

motivate them to use those skills once they have been acquired. We assume that there are many people who have acquired marginal reading and writing skills in school, who neither read nor write when they are no longer forced to do so, and consequently never become very proficient at either activity. This workshop did not address the question of whether technology might be applied usefully to the problem of motivating people with marginal literacy to read and write outside the instructional context, but we recognize this as a problem in its own right.

Literacy as a Culture Variable

In thinking about literacy training programs, one tends to focus on the individual. It may be, however, that in at least some cases, the cultural group to which the individual belongs is a more appropriate focus for training. As Scribner (1984, p. 7) reminds us, "the single most compelling fact about literacy is that it is a social achievement; individuals in societies without writing systems do not become literate." Many people in the United States who lack literacy skills live within subcultures that make little use of writing systems. Moreover, the meaning and role of literacy can differ among different cultural groups (Reder & Green, 1984).

Focusing on the group attention to such questions as what would literacy mean to the group as a group, and what would it mean to individuals vis-a-vis their roles and status within the group. The individual who is attempting to acquire reading

or writing skills as part of a group activity is in a rather different situation vis-a-vis the group than one who is doing it as an individual apart from the group. It seems likely also that the two situations have different implications regarding the relationship of the individual to the group after the training goals have been realized.

It is perhaps too easy to overlook the possibility that, for a person who lives in an illiterate subculture, not all the consequences of learning to read and write are positive. If becoming literate requires acting independently of one's peer group, status with respect to that group is likely to change and not necessarily only in desired ways. On the one hand, the ability to read and write may give one an elevated, or leadership status. On the other hand, it can also put one outside the group, especially if literacy and its perceived implications for one's lifestyle are not valued by the group.

Summary

Literacy is a complex and fluid concept. It has meant different things at different times and in different contexts. Recently the emphasis has been on functionality; what kinds of reading and writing skills must one have to function reasonably--without significant handicap--in today's society. There seems to be a general agreement that the demands are greater today than in the past and that a level of competence that might have been viewed as functional a few decades ago would not be considered

functional today. Arguments have been made that the appropriate goal for literacy training should be reading and writing competence at a twelth grade level.

The relationship between literacy and knowledge is now recognized to be a strong and bidirectional one. One can neither read comprehendingly about a subject nor write substantively about it unless one has more than a superficial knowledge of linguistics and of the world in general also play significant roles in comprehension. This has implications for the teaching of literacy; in particular it points up the importance of attending to the more cognitive aspects of reading and writing in literacy training programs. It establishes also the importance of taking account of the specific knowledge bases that beginning readers and writers bring to their tasks.

People read and write for a multitude of purposes. Efforts to teach literacy must recognize this fact and deal with the likelihood that different purposes may require somewhat different competences. The problem of motivation is viewed as a critical one and must also be addressed by programs if they are to have a chance of being successful.

Finally, literacy is a cultural variable. People read and write in sociocultural contexts. Literacy or the lack thereof has implications for one's standing and roles within the group or groups with which one most closely identifies. Efforts to teach literacy that overlook its cultural aspects and implications run

the risk of floundering because of unanticipated difficulties that have cultural origins. On the other hand, explicitly recognizing literacy as a cultural variable encourages the development of approaches that capitalize on the existence of the group and its communication functions to enhance the literacy skills of its members.

Technology and literacy

Recent Trends in Technology

Technology has developed explosively in the past few decades. Information technology, in particular, has developed more rapidly than anyone could have anticipated, and has affected our lives profoundly in countless ways. By information technology we mean technology that is applied to the problems of representing, storing, processing, and transmitting information. It includes, notably, computer and communication technologies. To provide a context for considering how information technology might be applied to the problem of literacy training, it may be helpful to note a few of the major trends in this technology over the recent past.

The cost of computing hardware, per unit of computing resource (e.g., executed instruction), has been decreasing by from 15 percent to 40 percent per year for 25 to 30 years (Branscomb, 1982; Knowles, 1982).

The number of active element groups (logic gates or memory cells) that can be put on a single semiconductor chip has

increased by roughly an order of magnitude every five years since 1960 (Phipps, 1982).

The speed at which computations can be performed increased by about 6 orders of magnitude over a period of 20 to 25 years.

The available computing power in the U.S. is increasing at the rate of about 40 percent per year (Branscomb, 1982).

As of 1984 there were an estimated six or seven million personal computers in U.S. homes (Business Outlook, 1984).

Given these trends and the fact that there is every reason to expect them to continue for the foreseeable future, we cannot lightly dismiss predictions that by 1990 microprocessor systems will be available for 100 dollars that have the computational power of the 1980's supercomputers (Lesgold & Reif, 1983). It is but a short step from this view of the future to that of Sutherland and Mead (1977), who have proposed that in figuring out how to use computer power to advantage in the future, we should begin to think of the hardware as being essentially free.

One especially salient prospect for the future is that of multimedia systems that will provide in one integrated system the capability of speech (both in and out), other audio, high-resolution graphics, facsimile, film, animation, and a variety of manual input modes. Such systems, especially when connectable to resource-sharing computer networks, should have great potential for applications in education and training.

Some observers have speculated that the further development of information technology and its application to education may change drastically not only the way educational services are delivered, but the institutions that deliver them. A recent report from the Secretariat of the Organization for Economic Cooperation and Development puts it this way: "The market is already lavishly supplied with video games, calculators, video recorders, and microcomputers with an educational character liable, unless something is done, to create a new sphere of 'education' outside the formal system" (Secretariat, 1984, p. 1).

A general effect of recent trends in information technology has been a rapid increase in the computing and communication resources that are available to the average person. These resources have the potential, we believe, to help address the problem of adult illiteracy, but it is a potential that remains to be developed.

Roles of Technology Vis-a-Vis Literacy

The implications of technology for literacy are somewhat paradoxical. On the one hand, radio and television have provided alternatives to reading as a major vehicle of entertainment and information acquisition; and the telephone has made us less dependent on writing as a means of communication with other people at a distance. So there is a sense in which people today who can neither read nor write may be less isolated, better entertained, and better informed than were their nineteenth

century counterparts. On the other hand, as a consequence of the effects of technology in the workplace, the literacy requirements for many jobs are considerably greater than they were only a few decades ago.

While the potential role of computers in education has been widely discussed in books, journal articles, conference proceedings, and the general press, relatively little has been said about possible applications of computer technology to the development of adult literacy. To be sure, the possibility that technology might be applied to this problem has not been entirely ignored. Among the questions Commissioner of Education Allen asked the National Academy of Education to address in 1969 was the following one:

What technologies do we have, and what technologies do we need to design, to make universal literacy a reality, given the heterogeneity of the American population, and assuming the increasing availability of educational institutions other than the formal school system (Fischer, 1975, p. ix).

Among the actions suggested by the NAE Committee on Reading to increase adult literacy was the exploitation of "new developments in educational technology, such as programmed and computer-assisted instruction and 'talking typewriters'. The reason given for this exploitation was 'the possibility of circumventing the problems of student motivation' that were seen to be "particularly acute in adult literacy programs" (p. 36).

Information technology can be used to address the problem of illiteracy in several ways. First, as we have already noted, it can and does provide alternatives to print literacy for acquiring and conveying information. The telephone, radio, and television are the most obvious examples of products of technology that supplement print as means of communication. The telephone makes it possible for us to communicate with others from a distance without knowing how to read or write. One can stay reasonably well informed about what is going on in the world through radio and television, again without print literacy. It is reasonable to expect that as information technology continues to evolve, additional and still more effective ways of acquiring and conveying information will be developed, and that many of these also will not require print literacy in order to be useful.

Second, technology could help bridge the gap between nonliteracy and literacy. It could facilitate the development of tools to help the nonliterate person manage print as a communication medium, at least to some degree. Speech-to-print and print-to-speech technologies, both of which are receiving a great deal of attention currently, are examples of aspects of information technology that have considerable promise in this regard.

Third, information technology has the potential to serve as an instructional medium to facilitate the development of literacy skills by those who lack them. It provides the basis for

developing teacher aids and amplifiers, as well as self-instruction or learn-alone facilitators. Planning for the application of technology to literacy training should take account of what is likely to become available by way of computer and video hardware over the next few years. In particular, it should take cognizance of the expectation that the cost of computing resources will continue to decline into the foreseeable future and that these resources will be widely used by people in many aspects of daily life.

The Continuing Importance of Facility with Text

In looking to the future, it is difficult to predict how further technological developments will change the importance of being literate. Some developments, such as systems that understand and produce speech, may decrease the need for reading and writing ability in certain contexts. However, as more and more jobs are automated, the intellectual demands of those that continue to be performed by human beings are likely to increase. Moreover, as we have already noted, our conception of what it means to be literate may change as computerbased systems become increasingly common and more and more people regularly use them.

We assume that literacy, even defined in the narrow sense of facility with text, will continue to be extremely important for the vast majority of people into the indefinite future, and that technology is unlikely to change that base fact. While it is true that information sources that do not require literacy have

increased markedly over the last few decades, one can take advantage of only a small fraction of the many sources that exist if one is unable to read. This is likely to continue to be so for the foreseeable future. With the development and proliferation of computer-based information services and utilities, the opportunities one will have for selectively obtaining information on a wide variety of us bjects will increase further, and while we anticipate that computer-based information services will increasingly offer voice output as an option, we believe that print-based facilities will provide the backbone of this technology and will remain much more comprehensive than alternatives for a long time to come. Consequently, the potential user of such facilities who lacks reading ability will continue to be a a serious disadvantage.

Moreover, even if computer-based systems that accept speech as input become commonplace, we see not even a remote possibility that that eventuality will greatly lessen the importance of being able to write, at least if writing is conceived broadly as the composition and editing of text. Electronic mail systems that accept voice input already exist, but they have not been well received (Seaman, 1983). One hypothesized reason for their unpopularity is the fact that the technology is not yet able to provide a visual representation of what was said (speech-to-print) and a capability to edit it. When the speech-to-print capability is in place, one will be able

to dictate a draft of a letter, look at it, and edit it, before sending it off to the addressee. This activity has all the ingredients of writing except the mechanical one of operating a pen or the keys of a typewriter.

In short, although technology may decrease the need to be able to read in some situations, and although it may continue to provide alternatives to reading as sources of both information and pleasure, reading ability is unlikely to become superfluous any time soon. Similarly, writing ability in the deepest sense will continue to be essential, even if the mechanical aspects of getting letters on paper or some other medium are partially replaced by other techniques. In considering the relationship between technology and literacy in the future, our focus rightly is on the question of how technology might be used to facilitate the teaching or acquisition of reading and writing skills.

Video as a Teaching Medium

One form of information technology that is already widely available, the potential of which for enhancing literacy should not be overlooked, is video. Video can be an extremely powerful medium for teaching. It can present situations and people with which the nonliterate learner is familiar and can model the value, uses, and techniques of literacy. It can be used to teach reading and writing skills, either by bringing the teacher (on camera) to the learner, or by manipulating test and speech in synchrony, or both.

While an interactive medium has many advantages, one advantage of noninteractive video is that of being nonthreatening and nonjudgmental to a degree that interactive techniques are unlikely to attain. Nonliterate individuals can learn from it (or not) as, when, and how they choose with no fear of testing or even of being observed. Any interactive medium, no matter how self-containedly resident in an individual microcomputer or other system, has implicit in its operation some kind of evaluation, or observation of the user's behavior at the very least.

As we have already noted, video is a major source of information for people who do not read. Moreover, it is a comfortable and pevasive medium. The vast majority of homes in the United States have at least one operating television set and many have more than one. If it is desirable to reach nonliterate people where they live, and where they feel most comfortable and least threatened, then video may be one medium choice. This is not to argue against the use of interactive media but simply to point out that a noninteractive one that is widely available anyway may also be used to advantage.

Computer-Based Message Technology

Electronic mail, or computer-based message technology more generally, represents a more recent technological development that is especially relevant to literacy training, because it represents a new communication medium and provides a new social

context for communication via written language. We need to try to understand the implications of this technology for literacy and the teaching of it. Does it provide an added incentive to be able to read and write? Are the reading and writing skills that are required for effective use of this medium in any way unique? Does the medium offer any special advantages as a vehicle for teaching literacy skills?

The use of word-processing software to facilitate the production of text permits one to take an attitude toward the process of writing or composition rather different from what would have been natural in the past. It is easier in this context to think of the desired product (e.g., letter, note, short story, memo) as something that one builds. The process involves deciding what it is one wants to say and perhaps trying out various ways of saying it, organizing and reorganizing parts and subparts of the composition, making corrections and modifications, at all stages of the process. One need not think in terms of a document, or portions thereof, as being right or wrong, but rather as in various stages of development. At some point, one becomes satisfied that a document is sufficiently close to what is wanted that the task may be considered done. But until that point, one is engaged in a dynamic process of shaping a product that may be changed in any way one wishes. Of course there is a sense in which one retains the flexibility to change a document that is being written in longhand. One is

always free to tear up what has been done and start again. However, the inconvenience of doing so acts against the adoption of the same mind set or view of the process.

What effect electronic mail and word-processing tools will eventually have on the style and quality of the writing produced by their users remains to be seen. There is at least anecdotal evidence that one of the effects these facilities have already had is that of making less formal styles of writing more acceptable, at least for some purposes. Often users of such systems use a "telegraphic" form of expression, which is characterized by abbreviations, incomplete sentences, nonuse of capitalization, and so on. In the interest of time, messages are composed at the terminal and sent in relatively unedited form. Although, to our knowledge, no one has reported formal data on the question, our impression is that some of the effects can be described as bringing the style of written communication closer to that of oral conversation, which tends to be much less formal, less grammatical, and less well organized than written language.

Need for Collaboration

There is a need for a closer collaboration among educators, educational researchers, and computer technologists on the problem of developing effective instructional software. It is not realistic to expect teachers or researchers who do not understand computers to be able to specify what educational software should be produced. Nor is it reasonable to expect

programmers who are neither knowledgeable with respect to teaching nor cognizant of the results of research that relate directly to literacy, to be able to produce software that will be educationally effective. What is needed in order to get effective educational software produced therefore is for teachers, researchers, and programmers who can work together to evolve something useful.

Use of the word "evolve" here reflects a considered choice. It will be an exception to the rule when educational software is produced that works precisely as it was intended to when it was originally conceived. What is far more likely to happen is that the ideas of the designers will be changed as the software is being developed. What often, perhaps typically, happens when one wants to produce a program to do a complex job is that one starts out to develop a program in accordance with some preliminary ideas, but then modifies and refines those ideas in the process of, and as a consequence of, producing working code and trying it out.

Summary

Technology, especially information technology, has been developing at an unprecedented rate during the last few decades. This has somewhat paradoxical implications for literacy. On the one hand, technology has provided alternatives to print as a means of disseminating information and for mediating communication between geographically separated individuals. On

the other hand, it has increased the need for relatively high levels of literacy both to compete for jobs and to have a reasonable level of understanding of the world in which we live.

Information technology can be used to address the problem of illiteracy in several ways: by continuing to provide alternatives to print, by helping to bridge the gap between literacy and non-literacy--helping non-literate persons to manage print as a communication medium--and by providing instructional media for literacy training.

We believe that in spite of the fact that technology provides alternatives to print for communication, facility with print will continue to be important for the foreseeable future, if not indefinitely. Moreover, as new ways of presenting information are developed, new forms of literacy will emerge that will represent further challenges to education.

The potential for applying information technology to the problem of literacy training is great. Possible vehicles range from television, which is now a well entrenched and widely available medium, to electronic mail, which is still in its infancy. Anything close to full realization of the potential that information technology respresents for enhancing literacy skills will require close collaboration among educators, researchers, and computer technologists. The problem is enormous, the tools are complex, and the available resources are very limited.

Some Possibilities For The Future

We believe there are many ways in which technology could be applied advantageously to the problem of teaching literacy. Identifying these possibilities is not a simple matter, however. Not everything that appears to be a possibility turns out to be realizable. Moreover, it has often happened to be the case in the past that the most significant technological developments were not recognized as possibilities before they were realized in fact.

Notwithstanding reservations about our ability to anticipate specific future developments, the effort to do so can be a useful exercise. It is from thinking about what appears to be possible, and from attempting to actualize some of those possibilities, that specific developments emerge. The actual developments may differ in many cases from what was originally imagined, but this does not diminish the importance of the role of the imagining as a causal factor in the chains of events that culminated in those developments.

One way in which technology might be used is to extend the outreach of the limited number of tutors by making more widely available, through computer software, approaches and techniques that are known to work. We agree with Jamison, Suppes, and Wells (1974) that the goal of applying technology to education should not be that of replacing teachers, but of increasing their productivity. To the extent that the approaches of the most

effective teachers can be represented in computer programs, those programs can deliver those techniques to many more students than could the teachers themselves. The use of small computers to deliver literacy training programs has the added advantage of facilitating the delivery of such programs to remote, otherwise relatively inaccessible, places (e.g., isolated rural areas).

A second possibliity is that technology may make some new approaches feasible that would not be possible without it. The potential of dynamic, interactive, computer-based graphics has barely begun to be tapped for educational purposes. While we do not yet know how best to exploit this potential for literacy training, we believe that when the question gets the attention it deserves, it will be possible to develop powerful new techniques. The existence of computer networks provides not only some new tools for facilitating the development of reading and writing skills but a new and different communication environment within which to exercise those skills.

In this section we note a few of the specific ways in which information technology might be applied to the problem of teaching literacy within the next few years. Some of these possibilities undoubtedly will be realized; others will not. On the whole they are representative of the types of things it would make sense to try. Trying them will lead not only to some new capabilities that could be usefully applied to the teaching of

literacy, but also to new ideas and an expansion of our conception of what the possibilities are.

Speech to Text

Concerted efforts are currently being made to develop computer-based systems that will accept continuous speech as input and provide a text display of what was said. While we do not know how long it will be before such systems exist, we can assume that they will exist eventually. There now are several commercially available systems that will recognize a modest number of isolated words after being "trained to work with a particular speaker (Petre, 1985; Schoen, 1985), and progress is being made on the problem of recognizing continuous speech. The questions of what potential current and future speech-to-text systems could have for literacy enhancement should be addressed.

Text to Speech

Text-to-speech systems--systems that will take text as input and "read out" that text as speech--already exist and are commercially available for some computer systems, although the technology is still young and somewhat shaky (Aarons, 1985; Nusbaum & Pisoni, 1984). Perhaps the best known example of application of this technology to a significant problem is the development of the Kurzweil reading machine for the blind (Kurzweil, 1984).

Text-to-speech systems should have considerable potential for application to literacy training. Uses of this capability that might serve this purpose include:

A conventional option-menu with the added feature that when one selects an item, not only does it blink, brighten, or change visually in some way, but also the selected item is spoken by the computer.

A system that can display text in the conventional way and speak words that the user identifies by moving a cursor or by pointing.

A system that can speak back to the user text that he has composed, as, for example, when writing a letter.

Personalized News Service

Many observers of trends in information technology expect that personalized news services will be widely available to subscribers through computer networks in the not-distant future. Consideration should be given to the possibility of using such facilities for the dual purpose of distributing news and enhancing literacy. One could imagine the same news items being prepared in two or three different forms, targeted for people with different levels of reading ability. The availability to the marginal reader of news of personal interest in simplified language might provide a continuing incentive to read and thereby to improve his reading skills.

Product Labels

One can imagine a program that used common product labels and brand names for teaching purposes. Consider, for example, a computer-based program that could display, in color, canned and packaged goods that one is likely to find on the shelves at one's local supermarket. The program could, in effect, read to the user the labels and various items of information appearing on the displayed can wrapper or package. As a given word is produced by a speech synthesizer, its visual representation could be intensified, made to blink, or otherwise highlighted on the display.

Scripts

One approach to teaching literacy that seems to us worth exploring is that of using scripts from prime-time television programs as teaching material. The learner could watch the program with script in hand. With a videodisk or video channel recorder (VCR), one would have the option of replay or of stopping action when necessary to allow more time for processing the written script. The use of captioned films, and especially captioned films recorded on videodisks or VCRs, so as to allow for replay, is also a possibility that should be explored. It would be desirable for this application of captioning that the captions be verbatim representations of what is actually said.

Games

The possibility of teaching some skills of literacy via computer-based games should be considered. Ideally, one wants games that are intrinsically motivating even to the person with minimum literacy to begin with, and that develop skills as a consequence of being played. One can imagine computer-based games or game-like situations in which interesting things happen when the computer is instructed by the right choice of words. The words could either be typed or, in a simpler mode, they could be selected from a menu of options.

High-Tech Versus Low-Tech

The question often arises as to when it makes sense to use a high-technology approach to a problem, and when it does not. In general, the question should be answered in simple cost-effectiveness terms. Of two equally effective techniques, the one that costs less is usually to be preferred. Of two equally costly techniques, one would normally select the one that promised the greater effectiveness. In evaluating cost-effectiveness, however, what is really important is incremental cost. One might properly question the use of a personal computer, for example, to implement an approach to learning that could as easily be implemented with, say, flash cards (e.g., for vocabulary drill). The flash cards are much cheaper, more portable, and, so far as we know, equally effective. However, in deciding whether it makes sense to implement a low-technology

procedure on a computer that is already available for other purposes, the cost that should be considered is the incremental cost of adding that procedure. In other words, while one could hardly justify getting a computer for the sole purpose of simulating flash cards, given that there are other reasons for having the computer, the additional cost of bringing up flash-card-like programs may be negligible. One might still argue that this would be an inefficient use of the computer, because it would fail to exploit its potential. An answer to that objection is that using the computer to implement relatively simple approaches that do not take advantage of its power in no way precludes the possibility of also implementing complex processes that do take advantage of it. The question that will be of greatest interest to the educator is not the degree to which a particular technique exploits the power of the computer, but rather how effectively it accomplishes a desired educational objective.

Learning Strategies

Learning strategies are strategies that one can apply to increase the effectiveness with which one undertakes any learning task. Much attention has been given by researchers in very recent years to the topic of learning strategies. Many of the learning strategies that have been studied assume literacy and are appropriate for people who are in a position to learn by applying the reading skills they already have. These include

such strategies as representing the information in text by network diagrams (Anderson, 1979; Dansereau & Holley, 1982) note-taking (Weinstein & Underwood, 1980) and summarizing (Ross & Divesta, 1978). There are strategies, however, that may be applicable to the more fundamental task of increasing one's literacy. Among learning strategies that seem to have been effective in other contexts that might also be usefully applied to literacy learning are the self management and performance monitoring strategies that have been promoted by Meichenbaum and others (Meichenbaum & Asarnow, 1979; Weinstein, Cubberly, & Richardson, 1982). The approach seems to have been effective in relieving anxiety and maintaining motivation.

The question of interest in the present context is whether technology could be applied effectively to the teaching of learning strategies that are especially well suited to the problem of literacy enhancement. This is a question for research; we believe the potential gain here is great enough to justify the necessary research effort.

Literacy Helpers

An approach to the teaching of literacy that deserves consideration is that of developing electronic "helpers" of various sorts. One can imagine, for example, a program designed to help a person who cannot read and write to compose a grocery shopping list. Icons could be used (along with words) as list items initially, but with the idea of gradually making the

individual less and less dependent on them and increasingly able to function only with the associated printed names. Another possibility along these lines would be to develop a facility especially designed for people with marginal writing skills. Thus, for example, one can imagine a system that would provide help in composing a simple letter or that would critique a letter and suggest improvements.

Systems with the capability to correct spelling, detect some types of grammatical errors, and suggest stylistic improvements in written text exist (Frase, 1983; Heidorn, Jensen, Miller, Byrd, & Chodorow, 1982; McDonald, 1983). The intended users of these systems appear to be people who have better than marginal writing skills to begin with, but the systems clearly have the potential of being adapted for use by those who do not. There also are some composition aids that have been designed specifically for children who are just learning to write (Owens, 1984; Watt, 1984; Rubin & Bruce, 1983). These too may have some potential for adaptation for use by adults. Independently of the question of the suitability or adaptability of existing writing-assistance software for use by adults who lack rudimentary writing skills, the existence of software that facilitates writing by adults who have such skills and of some that helps children acquire those skills strongly suggests the reasonableness of trying to design some writing-assistance software explicity for adults who cannot write. Quite possible

the use of such software would strengthen the user's reading skills as well as their ability.

We suspect that a variety of types of help might be identified that would benefit a person, or a community of people, who lacked reading and writing skills. One reasonable research objective would be to identify those types that might be implemented in software.

The notion of literacy helpers is not a new one. Many communities have one or more people who read and write for those who cannot do so for themselves. The idea of electronic helpers can be extended to that of helpers of helpers. Providing the human helpers with technological support might make it possible to increase their effectiveness and multiply their efforts.

Multimedia Dictionary

A challenging and, we believe, particularly worthwhile goal for a project would be the development of an interactive multimedia dictionary, especially designed for literacy training. Such a dictionary could make use of both computer and videodisk technology, and should have the ability to: (a) provide definitions of unrecognized words in terms of more common (higher frequency) words, (b) provide definitions in both written and spoken form, (c) supplement written definitions with pictorial representations of meanings (e.g., pictures of objects for concrete nouns, animated events for verbs), (d) accompany definitions with interactive activities to engage the learner in

the use of the defined words, (e) provide (perhaps on request by the user) synonyms or antonyms for specific words, (f) provide (again perhaps on request by the user) examples of words that are related to the word in question in specific ways.

This dictionary should be a rich source of information regarding language. It should be designed in such a way that effective use of it does not require that the user be highly competent with, and interacting with it should be intrinsically interesting. One can imagine that such a system might be sufficiently captivating that it could constitute an effective teaching instrument all by itself.

One can also imagine such a dictionary being customizable for specific user groups or even for specific individuals. In addition to general word frequency data (e.g., Thorndike & Lorge, 1944; Kucera & Francis, 1967), it could also contain information regarding specialized vocabularies (e.g., words that are especially useful for the purpose of producing grocery lists or reading about specific sports).

Developing of such a dictionary, designed especially for use as a literacy enhancement tool, would be an ambitious undertaking. The cost of its development would only have to be borne once, however. And, assuming that such a tool could be made widely accessible to users through personal computers, its development cost could be amortized over a sufficiently large user population that the cost per user would be small.

The development of such a system would have to proceed in an evolutionary fashion. However, because the system would be computer based, something useful could be made available at various stages of the evolutionary process. That is to say, an evolving system could be "frozen" for production and distribution long before its evolution was considered complete. Indeed it is not clear that the evolution of the system ever could, or should, be considered complete. The goal should be to produce something useful and the continually to improve upon that.

Interactivity and Individualization

Two of the most promising aspects of computer-based systems from the educator's point of view are interactivity and the potential for individualization. While interactivity is a characteristic of many existing programs, very little of the potential for customizing learning situations for individual learners has yet been realized. As Melmed (1983) puts it, "we are presently in the age of the Model T and the first flight at Kittyhawk in terms of our knowledge of how to individualize instruction."

One can imagine a literacy-enhancement system that has the capability of developing a model of an individual user and of tailoring training programs so as to be consistent with that model. The model would include, among other things, an internal representation of the learner's reading vocabulary and some estimate of the breadth and depth of his knowledge in specific

domains; and it would be revised continuously to reflect changes in the learner's vocabulary and knowledge base as a consequence of the training. For teaching, it would use passages that reflected the literacy needs and desires of the individual learner. Assessment data, which would provide the basis for developing models of what individual learners did and did not know about written language, could be obtained in the absence of explicit test, simply as a consequence of monitoring interactive training sessions (e.g., by noting the words that a learner is or is not able to recognize while performing a reading task). There is o the possibility of making use of adaptive testing techniques, which would allow the efficient assessment of the competency of individuals with respect to specific aspects of literacy and provide information that could be used to guide and tailor subsequent training.

Summary

The possibilities for applying technology to the problem of teaching literacy are many and diverse. They include techniques for facilitating and extending the delivery of existing approaches that have been shown to be effective and also the development of qualitatively different approaches.

We have noted a few specific possibilities that we consider to be worth exploring, ranging from relatively simple approaches, such as the use of common product labels along with pictographic representations and speech in a computer program, to the

ambitious possibility of developing a comprehensive multimedia dictionary. This list of possibilities is not presented as exhaustive, or even very extensive. It is intended only to be suggestive of the kinds of things that might be tried. We believe that efforts to explore such possibilities will reveal that some of them can indeed be the bases of effective approaches to literacy training whereas others, perhaps, cannot. More importantly, it is primarily from serious attempts to develop and test specific approaches that new and better ideas are likely to come.

Recommendations

Our primary recommendation is that the problem of adult illiteracy be recognized to be the profound and recalcitrant one that it is. Its costs are high--both for those people who lack adequate reading and writing skills and for society in general--and it has proven to be remarkably resistant to efforts to reduce its magnitude. Significant progress on this problem will not be made without an abiding major national commitment commensurate with the problem's importance to the future of the nation.

Our specific recommendations pertain to five topics: principles and perspective, research, development, service delivery, and evaluation.

Recommendations re Principles and Perspective

Promoting literacy development is a broader enterprise than increasing literacy training or enhancing skills that are

essential to literacy; it also must entail promoting increased engagement in acts of literacy, which is to say increased activity involving the use of reading and writing.

Efforts to develop programs to increase literacy should be informed by the findings of the considerable amount of research that has been done in recent years on reading and writing, and by the new conceptualizations of these processes that are emerging from that work.

Representative prospective users of literacy enhancement resources should be involved in identifying needs and evaluating experimental systems and techniques.

Programs to enhance adult literacy should put a premium on the teaching of useful skills from the very beginning. Ideally, a student should go away from an initial training session with the ability to do something that he wants to be able to do, but could not do before. Material that is used to teach reading skills to adults should be interesting, informative, and appropriate to the individuals' knowledge base; it should be material that the participants would really want to read if they were able to do so.

Priority also should be given the development of literacy training packages that not only enhance reading and writing skills but provide opportunities for the meaningful use of those skills. The opportunity to apply the skills that one is acquiring to desired objectives motivates the practice that is

necessary to assure the further development and retention of those skills. It also addresses the question of transfer in the most direct way possible. The fundamental question in any training program is whether the skills and knowledge acquired in the learning context transfer to the applications context of interest. If the learning context is the applications context, the question does not arise. Examples of existing computer-based packages that could serve both as training tools and as vehicles for applying what has been learned include electronic mail systems and document preparation tools.

Literacy training should not be disconnected from education and training more generally. Literacy should be viewed as an indispensable tool for learning, and the problem of how to enhance literacy should be viewed as one aspect of the general problem of how to help people become better learners.

Recommendations re Research

A report should be prepared under Department of Education sponsorship that describes what is currently being done by way of literacy training and summarizes whatever evidence exists regarding the effectiveness of specific programs and approaches. Such a survey document would provide useful guidance for future efforts to develop literacy training systems and procedures. In general, there is a need for better dissemination of information regarding what currently exists.

A study should be commissioned to attempt to determine what would constitute an effective, systematic approach to literacy training that would exploit computers and computer-related technologies, and would be informed by the best available research data regarding the acquistion of literacy.

One or more studies should be commissioned to investigate the potential for the use of computer-based games as vehicles for teaching (perhaps indirectly) skills essential to literacy.

Special attention should be given to the possibility that work sponsored by various government agencies, and in particular the Department of Defense, on expert systems has relevance to the literacy training problem.

Research should be done on the question of how to incorporate reading and writing activities into the communication patterns that already exist within social or cultural groups. Among other issues that should be considered is that of how a particular program could facilitate or improve communication among the members of the sociocultural group, and also how it could improve communication between that group as a group and the rest of the world. What, for example, might ready access to an electronic mail system mean in a ghetto?

Recommendations re Development

While we are not opposed to the development of independent programs that address specific aspects of literacy, or to the development of individual tools for use in literacy training, we

see the need for an integrated, comprehensive approach to the problem, and we recommend that the Federal government support the development of such an approach.

An attempt should be made to develop a variety of electronic "helpers" to assist persons lacking literacy skills to deal with print. In providing assistance in dealing with print, such helpers would enhance literacy incidentally.

As one way of addressing the problem of adapting software to specific sociocultural contexts, authoring systems should be developed that will permit target populations (communities) to customize the context of the program to their particular needs. A major emphasis in software development should be on tools that can be used to build programs addressed to needs of specific target groups.

Developers of literacy-training software should develop software that addresses the literacy needs of adults in the workplace, and in society in general, in such a way that the relevance of the training to those needs will be apparent to the trainees. Insofar as possible literacy should be taught in contexts that are very similar to those in which the newly acquired literacy skills are expected to be used. In general, communication skills are best taught in contexts in which people are communicating and are using what they are learning for that purpose.

An effort should be made to ensure that the reading material that is to be used to help teach nonliterate people to read is intrinsically interesting to the learners.

Recommendations re Service Delivery

Literacy should be perceived as a sociocultural variable; being literate (or illiterate) means different things and has different implications in different sociocultural contexts. Attention should be given to the needs and uses of literacy within the sociocultural group to which individuals who are receiving literacy training belong, so that training programs can be informed by, and responsive to, those needs and uses.

Inasmuch as many people who lack literacy skills are unlikely to go to a school, ways should be found to bring the opportunity for literacy training to the people who can benefit from it. An attempt should be made to identify ecologically reasonable (natural) places for teaching literacy. These places would presumably include those where people spontaneously gather, such as churches, shopping centers, YMCAS, YWCAs, recreational facilities, social clubs, and union halls.

An investigation should be made into more effective ways to disseminate information about existing software and to make available software that there is reason to believe is effective. A clearinghouse or directory of programs and evaluation reports and data should perhaps be established. One of the most

significant challenges facing the educational establishment generally is that of finding a way of making the best ideas embodied in numerous educational computer programs that currently exist more widely and easily available. There is a need for some effective mechanisms for collecting, cataloging, and distributing existing programs and ideas regarding the use of computers for educational purposes in general and for literacy training in particular.

More attention should be given to the question of how to get from participants in literacy training programs the commitment necessary to assure a reasonable chance of success. The problem of dropouts appears to be a particularly significant one. A sizable fraction of the people who enroll in literacy programs drop out after the first one or two training sessions. We need to understand better why people who have shown enough interest to enroll in a program fail to continue in it. Undoubtedly, there are several reasons for dropping out; however, it may be that a few of them account for a large percentage of the cases. The identification of these could be helpful in the design of more effective programs.

Recommendations re Evaluation

An effort should be made to develop an approach to evaluation that is relatively certain to yield conclusive, or at least interpretable, data. This is a challenge to the educational research community and to the various agencies that

support educational research. Evaluations that are intended to produce conclusive evidence of lasting impact require careful longitudinal studies.

More emphasis should be placed on formative evaluations that will yield the kind of information that can be of use in shaping and improving literacy-training tools and programs.

An effort should be made to articulate basic principles that can be used by the consumer to evaluate educational software. Something as simple as a check list of what to look for, what questions to ask of a developer or vendor, could be useful.

The government should promote and support the establishment of a facility for evaluating literacy-training software and disseminating the results of evaluations to potential users. There is a critical need for accessible evaluative information regarding educational software and software addressed to the problem of teaching literacy in particular. Who should do evaluations is, at this point, an open question.

Conclusion

Even if the figures that are widely quoted regarding the prevalence of illiteracy among adults in the United States are high by a factor of two, the country has a real problem. Moreover, it is a problem for which there is no quick and simple solution. Learning to read and write well enough to participate fully in mainstream activities of a print-oriented society is a time-consuming process that requires commitment and perseverance

by both learner and teacher. The approaches that have been used to address this problem in the past have manifestly not worked very well. If the figures are to be believed, only a tiny fraction of the adult population that needs literacy training is receiving it; and there is a little evidence that that training is highly effective, or that the magnitude of the problem is decreasing.

There clearly is a need for new approaches to the teaching of literacy. We believe that information technology has the potential to yield some new approaches. We have tried to say in this report why we believe that to be the case, and to identify some possible directions that attempt to exploit information technology for this purpose might take. We have not aspired to present anything like an exhaustive, or even an extensive, list of possibilities, but simply to point out a few examples of the kinds of things that might be done. We believe that concerted efforts to apply information technology to literacy training in specific ways would yield an abundance of ideas deserving of consideration.

The problem of adult illiteracy has been with us for a long time. It is not likely to disappear immediately no matter what is done to address it. Whether it grows to indisputably crisis proportions, or begins to diminish appreciably, will depend upon the strength of the nation's resolve to develop and apply approaches to the teaching of literacy that are more effective

than those that have been used in the past. While information technology has great potential for helping to address this problem, it is a potential that, for the most part, is not only undeveloped but unexplored.

Looking beyond the problem of adult illiteracy in the United States, we note the desirability of developing approaches to the teaching of literacy that have general applicability across national, cultural, and linguistic boundaries. Literacy is a worldwide concern. The ability to read is fundamental to education, inasmuch as reading is the primary means by which individuals acquire the kind of knowledge that an educated person is expected to possess. Inability to write deprives one of a primary means of expression in a print-oriented world. Illiteracy is a special problem for lesser developed countries, because widespread illiteracy in a population greatly inhibits a country's economic and technological development. The ultimate goal should be to solve the problem of adult illiteracy by prevention. That will require the use of more effective approaches to the teaching of literacy to children than have been used in the past. Recognizing the universal scope of this challenge, we believe an effort should be made to develop technology-based generic approaches to the teaching of literacy that can be adapted to specific national, cultural, and linguistic contexts.

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